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Patent Application for:

EXTERNAL MEMORY FOR PVR

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7 **EXTERNAL MEMORY FOR PVR**
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10 **CROSS REFERENCE TO RELATED DOCUMENTS**

11 This application is related to and claims priority benefit of U.S. Provisional
12 Patent Application number 60/261,474, filed January 11, 2001, entitled "External
13 Memory for PVR" which is hereby incorporated herein by reference.
14

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22 **FIELD OF THE INVENTION**

23 This invention relates generally to the field of personal video recorders
24 (PVR). More particularly, this invention relates to external storage devices for a
25 PVR.
26

27 **BACKGROUND OF THE INVENTION**

28 Personal Video Recorders (PVR) are becoming popular devices for
29 recording television programming for later viewing. PVRs use computer disc drives

1 as the storage media as opposed to tape as in video tape recorders. This provides
2 numerous advantages including the ability to pause a "live" TV program that is
3 currently being viewed, quickly access a stored program or record multiple
4 programs simultaneously. As such PVR devices become more popular, the
5 internal storage provided with the PVR may be inadequate for some users. It is
6 therefore desirable to provide a user with the ability to attach an external disc drive
7 to the PVR to increase the storage capacity, or to provide storage capacity to a
8 television Set-Top Box (STB). However, it is also desirable that restricted
9 programming not be available "in the clear" for unauthorized copying.

10 11 **SUMMARY OF THE INVENTION**

12 The present invention relates generally to personal video recorders. Objects,
13 advantages and features of the invention will become apparent to those skilled in
14 the art upon consideration of the following detailed description of the invention.

15 For purposes of this document, it will be understood that the present
16 technology can be used with a PVR or a STB and those terms are used
17 interchangeably herein as equivalents, with the exemplary embodiments illustrated
18 in terms of a PVR. However, the term PVR or STB can be interpreted as
19 equivalents for the purposes of the present invention. Moreover, the technology of
20 a PVR or STB with storage capabilities may be integrated within a television set
21 itself without being embodied within the literal bounds of a Set-Top Box per-se.
22 The present invention is intended to embrace all such alternatives.

23 In one embodiment of the present invention an external storage device is
24 provided for a personal video recorder. An MPEG transport stream is filtered to
25 remove information not relevant to a selected program. This filtered transport
26 stream is encrypted and then transmitted as isochronous data over an IEEE 1394
27 bus to an external storage device. The external storage device decrypts the filtered
28 transport stream and returns PAT and PMT tables to the personal video recorder.
29 Those tables are edited to remove information not relevant to the selected program
30 and returned to the external storage device for reinsertion into the transport stream

1 to produce a modified transport stream. This modified transport stream is stored
2 on the external hard disc drive. The modified transport stream may be encrypted
3 prior to or after storage on the hard disc drive. If the selected program is scrambled
4 at the system head end, the program is descrambled in the PVR (or STB) before
5 the filtering using a key which is contained in the ECM and delivered with the
6 program on the MPEG Transport Stream.

7 In one embodiment consistent with the present invention, an external storage
8 device for a personal video recorder (PVR) or television Set-Top Box (STB) includes
9 means for receiving an encrypted and filtered MPEG transport stream, the filtered
10 MPEG transport stream containing only components having content related to a
11 single program. A decrypter decrypts the encrypted and filtered MPEG transport
12 stream to produce a filtered MPEG transport stream. A demultiplexer receives the
13 filtered MPEG transport stream and extracts an MPEG table therefrom. A formatter
14 reinserts an MPEG table back into the filtered MPEG transport stream to produce
15 a modified MPEG transport stream, the reinserted table containing only information
16 relevant to the single program. A disc drive stores the modified MPEG transport
17 stream.

18 In another embodiment consistent with the present invention, an adapter for
19 adapting an external storage device for storing information from a personal video
20 recorder (PVR) or television Set-Top Box (STB) has means for receiving an
21 encrypted and filtered MPEG transport stream, the filtered MPEG transport stream
22 containing only components having content related to a single program. A
23 decrypter decrypts the encrypted and filtered MPEG transport stream to produce
24 a filtered MPEG transport stream. A demultiplexer receives the filtered MPEG
25 transport stream and extracts an MPEG table therefrom. A formatter reinserts an
26 MPEG table back into the filtered MPEG transport stream to produce a modified
27 MPEG transport stream, the reinserted table containing only information relevant
28 to the single program. The modified MPEG transport stream is coupled to a disc
29 drive.

30 An external storage device for a personal video recorder (PVR) or television

1 Set-Top Box (STB) consistent with an embodiment of the present invention includes
2 means for receiving an encrypted and filtered MPEG transport stream, the filtered
3 MPEG transport stream containing only components having content related to a
4 single program, wherein the encrypted and filtered MPEG transport stream is
5 receive as isochronous data over an IEEE 1394 bus. A decrypter decrypts the
6 encrypted and filtered MPEG transport stream using 5C decryption to produce a
7 filtered MPEG transport stream. A demultiplexer that receives the filtered MPEG
8 transport stream and extracts MPEG tables comprising a program association table
9 (PAT) and a program map table (PMT) therefrom, and wherein the demultiplexer
10 further extracts an entitlement control message (ECM) from the filtered transport
11 stream. The MPEG tables extracted by the demultiplexer are sent to the PVR or
12 STB over the IEEE 1394 bus as asynchronous data. A formatter reinserts the
13 MPEG PAT and PMT tables back into the filtered MPEG transport stream to
14 produce a modified MPEG transport stream, the reinserted tables containing only
15 information relevant to the single program, wherein the formatter receives the
16 MPEG table to be reinserted as asynchronous data over the IEEE 1394 bus. An
17 encrypter encrypts the modified transport stream using 5C encryption. A disc drive
18 stores the encrypted modified MPEG transport stream. A pass through switch can
19 be used for selectively bypassing the disc drive.

20 A method of storing data on a disc drive external to a personal video recorder
21 (PVR) or television Set-Top Box (STB) in an embodiment consistent with the
22 present invention includes receiving an MPEG transport stream; filtering the MPEG
23 transport stream to extract portions of the MPEG transport stream relevant to a
24 selected program; encrypting the filtered MPEG transport stream; sending the
25 MPEG transport stream to the external disc drive; at the external disc drive,
26 decrypting the filtered MPEG transport stream; removing an MPEG table from the
27 filtered MPEG transport stream; editing the MPEG table to remove information not
28 relevant to the selected program; reinserting the edited table into the filtered MPEG
29 transport stream to produce a modified MPEG transport stream; and storing the
30 modified MPEG transport stream to the disc drive.

1 A method, consistent with an embodiment of the present invention, of storing
2 data on a disc drive external to a personal video recorder (PVR) or television Set-
3 Top Box (STB), includes receiving an encrypted and filtered MPEG transport
4 stream; decrypting the filtered MPEG transport stream; removing an MPEG table
5 from the filtered MPEG transport stream; sending the MPEG table to the PVR or
6 STB; receiving an edited table from the PVR or STB; reinserting the edited table
7 into the filtered MPEG transport stream to produce a modified MPEG transport
8 stream; and storing the modified MPEG transport stream to the disc drive.

9 In another embodiment consistent with the present invention, a method of
10 storing data from a Personal Video Recorder (PVR) or television Set-Top Box to an
11 external storage device, includes filtering an MPEG transport stream to remove
12 components that do not contain information related to a selected program;
13 encrypting the MPEG transport stream to produce a filtered and encrypted MPEG
14 transport stream; sending the filtered and encrypted MPEG transport stream to the
15 external storage device; receiving an MPEG table from the external storage device;
16 editing the MPEG table to remove information not related to the selected program;
17 and sending the edited table to the external storage device.

18 A digital storage device consistent with an embodiment of the invention
19 includes a disc drive. An interface receives an IEEE 1394 isochronous data stream
20 containing encrypted data formatted as an MPEG transport stream into the digital
21 storage device. A decrypter that decrypts the encrypted data for storage on the disc
22 drive. An encrypter encrypts the data for transport out of the digital storage device
23 as an IEEE 1394 isochronous data stream.

24 Any of the methods described above can be stored as instructions for
25 execution on a programmed processor on any suitable electronic storage medium.

26 The above summaries are intended to illustrate exemplary embodiments of
27 the invention, which will be best understood in conjunction with the detailed
28 description to follow, and are not intended to limit the scope of the appended
29 claims.
30

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the invention believed to be novel are set forth with particularity in the appended claims. The invention itself however, both as to organization and method of operation, together with objects and advantages thereof, may be best understood by reference to the following detailed description of the invention, which describes certain exemplary embodiments of the invention, taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a block diagram of an exemplary system using a personal video recorder device / Set-Top Box and an external disc drive.

FIGURE 2 is a more detailed block diagram of an exemplary PVR / STB and external storage device.

FIGURE 3 is a block diagram depicting an alternative embodiment of an external storage device using an adapter and a hard disc drive.

FIGURE 4 is a flow chart of an embodiment of a method consistent with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail specific embodiments, with the understanding that the present disclosure is to be considered as an example of the principles of the invention and not intended to limit the invention to the specific embodiments shown and described. In the description below, like reference numerals are used to describe the same, similar or corresponding parts in the several views of the drawings.

Referring now to **FIGURE 1**, an exemplary system 100, consistent with an embodiment of the present invention, has a content source 106, such as a cable TV network, satellite TV system or broadcast television station or the like 106 providing content to a Set-Top Box or personal video recorder 110. Personal video recorder 110 in turn supplies content either in real time from content source 106 or

1 from storage to a display 114 for viewing by the user. It may be desirable to attach
2 an external disc drive 120, for example using an IEEE 1394 bus 126, to the
3 Personal Video Recorder as a mechanism of expanding the amount of storage
4 available to the PVR. While the IEEE 1394 bus is preferred, other interconnections
5 may also be used, including wired and wireless connections, without departing
6 from the present invention.

7 PVR 110 and external disc drive 120 connected by an IEEE 1394 interface
8 126 is illustrated in **FIGURE 2** in greater detail. In order to minimize storage
9 requirements in the external disc drive 120, it is desirable that only information
10 relevant to the program being stored form a part of the data stored in disc drive 120.
11 A conventional MPEG transport stream includes a substantial amount of
12 information that, if stored as an MPEG transport stream, would be unnecessary to
13 the storage of the program of interest. The present invention, in certain
14 embodiments, therefore strips all irrelevant information with regard to the program
15 being stored from the transport stream before storing the program.

16 Within the PVR 110, the full MPEG transport stream is received by a
17 descrambler 208 that performs the descrambling function in a conventional
18 manner. That is, a decryption key is extracted from an Entitlement Control
19 Message (ECM) in demultiplexer 224 and sent to conditional access processor
20 234. Conditional access processor 234 provides the key from the ECM to
21 descrambler 208 to effect the descrambling. The descrambled transport stream
22 is then applied to a filter 212. The filter 212, under control of the partial transport
23 stream controller 238 (which is controlled by the PVR controller) acting on
24 instructions from the user to select the particular channel, filters the descrambled
25 MPEG transport stream into a partial transport stream or a filtered transport stream
26 that contains elemental streams containing the program content plus selected
27 other information relating to the program. For example, this filtered transport
28 stream, in addition to elemental audio and video data streams, includes the
29 Entitlement Control Message (ECM) which includes decryption keys, descrambling
30 keys and conditional access related information, the Program Association Table

1 (PAT) that contains information relating a program number with a packet identifier
2 (PID) in the transport stream, and the Program Map Table (PMT) which maps the
3 PID to the elemental data streams in the transport stream (e.g., video, audio, etc.).
4 The filtered transport stream may also include other information relevant to the
5 currently selected program.

6 The filtered transport stream from filter 212 is then provided to an encrypter
7 216 that encrypts the data and/or the transport stream for transport to the external
8 disc drive 120. In the preferred embodiment, industry standard 5C encryption is
9 used to encrypt the information in the filtered transport stream at encrypter 216.
10 The encrypted filtered transport stream from encrypter 216 is then sent to the
11 external disc drive 120 as isochronous data over an IEEE 1394 bus 126. Of course,
12 in other embodiments, communication media and bus arrangements other than
13 IEEE 1394 can be used without departing from the present invention.

14 When the encrypted filtered transport stream is received by the external
15 storage device 120, it is first applied to a decrypter 220 that decrypts the encrypted
16 information utilizing an encryption algorithm suitable for the encrypted information.
17 In the preferred embodiment, this is 5C encryption. The decrypted filtered transport
18 stream is then supplied to a demultiplexer 224. Demultiplexer 224 extracts the
19 program content bearing elemental streams from the filtered MPEG transport
20 stream and applies it to a formatter 230. Other information such as the ECM, PAT
21 and PMT tables are sent back to the PVR 110 from demultiplexer 224, preferably
22 using asynchronous communication over the IEEE 1394 bus 126. The ECM
23 information is applied to a conditional access processor 234 that extracts the
24 descrambling key for use by descrambler 208. The PAT and PMT are sent to a
25 partial transport stream controller 238. Partial transport stream controller 238 may,
26 in fact, be implemented as part of the PVR controller 204 or may be handled by
27 separate hardware and/or software without departing from the invention.
28 Conditional access processor 234 may similarly be part of the PVR controller or
29 may be implemented as a separate hardware or software processor.

30 Conditional access processor 234 provides access control information (AC)

1 to the partial transport stream controller 238. The access control information from
2 conditional access processor 234 is extracted from the ECM information. Transport
3 stream controller 238 processes (edits) the PAT and PMT information to remove
4 any information from these tables which is not directly related to the selected
5 program being stored. These edited tables are then returned to the formatter 230,
6 preferably over an asynchronous data path in the IEEE 1394 bus. Formatter 230
7 then recombines the revised PAT and PMT into the filtered MPEG data stream so
8 that the data stream only contains information directly related to the selected
9 program (i.e., elemental audio and video streams plus MPEG tables edited to
10 remove all information not relevant to the selected program). Formatter 230 then
11 applies this revised data stream to hard disc drive 234 for storage through a switch
12 238.

13 Switch 238 operates under control of the PVR controller 204 via instructions
14 received, e.g., over an asynchronous data path in IEEE 1394 bus 126, to determine
15 if the information is to be stored in the hard disc drive 234 or bypass the hard disc
16 drive 234. In the event switch 238, along with switch 242 are configured for
17 bypassing the hard disc drive 234, the revised data stream is passed to an
18 encrypter 248 for re-encryption (e.g. using 5C encryption) and returned to the PVR
19 110, preferably via an isochronous data path. In this bypass mode, the encrypted
20 revised data stream from 248 is applied to a decrypter 254 for decryption of the
21 program material. The decrypted transport stream is applied to a demultiplexer 260
22 which sends the program content to a decoder 264 for decoding into a video
23 stream. The other information is sent to a decode controller 268 to effect controls
24 on decoder 264 in a known manner to permit decoding the transport stream into
25 video by decoder 264.

26 In another mode of operation, wherein the switch 238 supplies the transport
27 stream to the hard disc drive 234, switch 242 may be configured to read the data
28 that is currently being recorded or read data related to a previously recorded
29 program, and forward that data to encrypter 248 for a playback. In this mode of
30 operation, playback may occur while recording is taking place, with the playback

1 being either the current selected program that is being recorded or any other
2 program already stored on hard disc drive 234.

3 Referring now to **FIGURE 3**, it may be desirable in some embodiments to
4 utilize an external disc drive adapter 320 in conjunction with a conventional hard
5 disc drive 334 to provide external storage to the PVR. In this embodiment, all of the
6 various components function in the same manner as previously described except
7 that excrypter 248 is placed after formatter 230 and before switch 238. In this
8 manner, the information stored on hard disc drive 334 is stored in encrypted form
9 so as to prevent easy access to restricted information in the clear. In another
10 embodiment not illustrated, encrypter 248 can be placed after formatter 230 in
11 external disc drive 120 of **FIGURE 2** without departing from the invention. In this
12 embodiment, information is similarly encrypted before it is placed on hard disc drive
13 234. Many such variations are possible without departing from the present
14 invention.

15 In each of the embodiments illustrated, no mention has been made explicitly
16 of the IEEE 1394 interfaces at the borders of the PVR and at the external storage
17 device or external disc drive adapter. Similarly no mention has been made of a
18 hard disc drive controller to control disc drive 234 or disc drive 334. However, those
19 skilled in the art will understand that conventional circuitry can be utilized to
20 construct such interfaces, the details of which are not important to understanding
21 the present invention. In the case of hard disc drive 234 and 334, a SCSI interface
22 can be utilized as well as EIDE interfaces without departing from the present
23 invention. Other interfaces can also be used, as will be clear to those skilled in the
24 art.

25 **FIGURE 4** depicts the overall process used to store information in the
26 external disc drive 120 in accordance with the embodiments of the present
27 invention. This process is illustrated as process 400 starting at 404. At 408 an
28 MPEG transport stream is received at the PVR 110. The transport stream is filtered
29 to extract portions of the transport stream that are relevant to the currently selected

1 program at 412. After filtering, this transport stream may still include extraneous
2 information within, for example, the PAT and PMT tables.

3 The filtered transport stream is encrypted at 416 and sent to the external
4 storage device 120, for example, via an isochronous connection using an IEEE
5 1394 interface. At the external storage device, the filtered transport stream is
6 decrypted at 420. Tables are removed from the filtered transport stream at 424 (for
7 example the ECM, PMT and PAT tables.) These tables are then edited (for
8 example in the PVR but possibly also in the external storage device) to eliminate
9 information that is not relevant to the currently selected program at 430. The edited
10 tables are then inserted back into the filtered transport stream to produce a
11 modified transport stream at 434, and the ECM is processed to provide the
12 descrambling key for descrambler 208 (via conditional access processor 234).

13 At this point, the modified transport stream includes only information relevant
14 to the selected program. However, the transport stream is still digitally formatted
15 to comply with MPEG standards, in the preferred embodiment. Depending on the
16 embodiment, this modified transport stream may be encrypted at 438 (optional)
17 before being stored to a disc drive or other persistent storage at 444. The process
18 ends at 450.

19 Thus, the present invention provides a mechanism for minimizing storage
20 requirements in an external disc drive while utilizing conventional MPEG transport
21 stream formats throughout with encryption being utilized to protect the content.

22 Those skilled in the art will recognize that the present invention has been
23 described in terms of exemplary embodiments based upon use of a programmed
24 processor. However, the invention should not be so limited, since the present
25 invention could be implemented using hardware component equivalents such as
26 special purpose hardware and/or dedicated processors which are equivalents to
27 the invention as described and claimed. Similarly, general purpose computers,
28 microprocessor based computers, micro-controllers, optical computers, analog
29 computers, dedicated processors and/or dedicated hard wired logic may be used
30 to construct alternative equivalent embodiments of the present invention.